

## WHAT IS CLAIMED IS:

### 1. An image encoding apparatus comprising:

filtering means for generating a plurality of sub-bands, and applying hierarchical filtering to the sub-bands;

code block generating means for splitting the sub-bands generated by said filtering means for generating a plurality of code blocks each being of a predetermined size;

bitplane generating means for generating a plurality of bitplanes from the most significant bit to the least significant bit, in terms of said code block as a unit;

encoding object predicting means for predicting the number of bitplanes for encoding, as object of the encoding, and for extracting, from an upper bit side of each code block, a number of bitplanes corresponding to the predicted number of bitplanes for encoding;

bit modeling means for performing bit modeling from one bitplane extracted by said encoding object predicting means to another;

encoding pass generating means for generating an encoding pass from one bitplane to another;

arithmetic coding means for performing arithmetic coding in the encoding passes generated by said encoding pass generating means;

code volume controlling means for controlling the code volume, based on

arithmetic codes generated by said arithmetic coding means, so that a target code volume will be reached; and

packet generating means for appending a header to the arithmetic codes controlled as to code volume by said code volume controlling means, to generate a packet.

2. The image encoding apparatus according to claim 1 wherein said encoding object predicting means counts the number of effective bitplanes, excluding zero bitplanes, for the totality of the code blocks in a frame in said input picture, and reference is made to a predetermined table, based on the count results, to find the number of bitplanes for encoding, from one frame to another.

3. The image encoding apparatus according to claim 2 wherein said predetermined table is such a table in which the range of values of the effective bitplanes is correlated with the number of the bitplanes for encoding.

4. The image encoding apparatus according to claim 1 wherein said encoding object predicting means counts the number of the effective bitplanes, excluding zero bitplanes, for the totality of the code blocks in the sub-bands of said input picture, and wherein reference is made to said predetermined table, based on the count results, to find the number of the bitplanes for encoding, from one sub-band to another.

5. The image encoding apparatus according to claim 4 wherein said predetermined table is such a table in which the range of values of the effective

bitplanes is correlated with the number of bitplanes for encoding, from one sub-band to another.

6. The image encoding apparatus according to claim 5 wherein, when the input picture is an interlaced picture, the number of bitplanes for encoding, associated with the sub-band with the highest splitting level, which is in the low range in the horizontal direction and which is in the high range in the vertical direction, is set to zero.

7. The image encoding apparatus according to claim 5 wherein, when the input picture is an interlaced picture, the number of bitplanes for encoding, associated with the sub-bands of the totality of splitting levels, which are in the low range in the horizontal direction and which are in the high range in the vertical direction, is set to zero.

8. The image encoding apparatus according to claim 2 wherein said predetermined table is stored in a ROM (read-only memory).

9. An image encoding apparatus comprising:

filtering means for generating a plurality of sub-bands, and applying hierarchical filtering to the sub-bands;

code block generating means for splitting the sub-bands generated by said filtering means for generating a plurality of code blocks each being of a predetermined size;

bitplane generating means for generating a plurality of bitplanes from the

most significant bit to the least significant bit, in terms of said code block as a unit;

encoding object predicting means for predicting the number of encoding passes for encoding, as object of the encoding, for generating the information on the number of the encoding passes;

bit modeling means for performing bit modeling from one bitplane to another;

encoding pass generating means for generating encoding passes from one bitplane to another;

arithmetic coding means for performing arithmetic coding only on a number of the encoding passes, afforded by the information on the number of encoding passes, as counted from the most significant bit side of each code block, from among the encoding passes generated by said encoding pass generating means;

code volume controlling means for controlling the code volume, based on an arithmetic code generated by said arithmetic coding means, so that a target code volume will be reached; and

packet generating means for appending a header to the arithmetic code, controlled as to code volume by said code volume controlling means, to generate a packet.

10. An image encoding method comprising:

a filtering step of generating a plurality of sub-bands, and applying hierarchical filtering to the sub-bands;

a code block generating step of splitting the sub-bands generated by said filtering step to generating a plurality of code blocks each being of a predetermined size;

a bitplane generating step of generating a plurality of bitplanes from the most significant bit to the least significant bit, in terms of said code block as a unit;

an encoding object predicting step of predicting the number of bitplanes for encoding, as object of the encoding, and for extracting, from an upper bit side of each code block, a number of bitplanes corresponding to the predicted number of bitplanes for encoding;

a bit modeling step of performing bit modeling from one bitplane extracted by said encoding object predicting means to another;

a step of generating an encoding pass from one bitplane to another;

an arithmetic coding step of performing arithmetic coding in the encoding pass generated by said encoding pass generating means;

a code volume controlling step of controlling the code volume, based on arithmetic codes generated by said arithmetic coding means, so that a target code volume will be reached; and

a packet generating step of appending a header to the arithmetic codes controlled as to code volume by said code volume controlling means to generate a packet.

11. An image encoding apparatus comprising:

a filtering step of generating a plurality of sub-bands, and applying hierarchical filtering to the sub-bands;

a code block generating step of splitting the sub-bands generated by said filtering step to generate a plurality of code blocks each being of a predetermined size;

a bitplane generating step of generating a plurality of bitplanes from the most significant bit to the least significant bit, in terms of said code block as a unit;

an encoding object predicting step of predicting the number of encoding passes for encoding, as object of the encoding, for generating the information on the number of the encoding passes;

a bit modeling step of performing bit modeling from one bitplane to another;

a step of generating an encoding pass from one bitplane to another;

an arithmetic coding step of performing arithmetic coding only on a number of the encoding passes, afforded by the information on the number of encoding passes, as counted from the most significant bit side of each code block, from among the encoding passes generated by said encoding pass generating means;

a code volume controlling step of controlling the code volume, based on an arithmetic code generated by said arithmetic coding step, so that a target code volume will be reached; and

a packet generating step of appending a header to the arithmetic code, controlled as to code volume by said code volume controlling means, to generate a

packet.

12. A program for having a computer execute a preset processing comprising:

- a filtering step of generating a plurality of sub-bands, and applying hierarchical filtering to the sub-bands;

- a code block generating step of splitting the sub-bands generated by said filtering step to generate a plurality of code blocks each being of a predetermined size;

- a bitplane generating step of generating a plurality of bitplanes from the most significant bit to the least significant bit, in terms of said code block as a unit;

- an encoding object predicting step of predicting the number of bitplanes for encoding, as object of the encoding, and for extracting, from an upper bit side, a number of bitplanes corresponding to the predicted number of bitplanes for encoding;

- a bit modeling step of performing bit modeling from one bitplane extracted by said encoding object predicting means to another;

- a step of generating an encoding pass from one bitplane to another;

- an arithmetic coding step of performing arithmetic coding in the encoding pass generated by said encoding pass generating means;

- a code volume controlling step of controlling the code volume, based on arithmetic codes generated by said arithmetic coding means, so that a target code volume will be reached; and

a packet generating step of appending a header to the arithmetic codes controlled as to code volume by said code volume controlling means to generate a packet.

13. A program for having a computer execute preset processing, comprising:

a filtering step of generating a plurality of sub-bands, and applying hierarchical filtering to the sub-bands;

a code block generating step of splitting the sub-bands generated by said filtering step to generate a plurality of code blocks each being of a predetermined size;

a bitplane generating step of generating a plurality of bitplanes from the most significant bit to the least significant bit, in terms of said code block as a unit;

an encoding object predicting step of predicting the number of encoding passes for encoding, as object of the encoding, for generating the information on the number of the encoding passes;

a bit modeling step of performing bit modeling from one bitplane to another;

a step of generating encoding pass from one bitplane to another;

an arithmetic coding step of performing arithmetic coding only on a number of the encoding passes, afforded by the information on the number of encoding passes, as counted from the most significant bit side of each code block, from among the encoding passes generated by said encoding pass generating means;

a code volume controlling step of controlling the code volume, based on an



arithmetic code generated by said arithmetic coding means, so that a target code volume will be reached; and

a packet generating step of appending a header to the arithmetic codes, controlled as to code volume by said code volume controlling means, to generate a packet.

14. A computer-readable recording medium having recorded thereon a program for having a computer execute preset processing, said program comprising:

a filtering step of generating a plurality of sub-bands, and applying hierarchical filtering to the sub-bands;

a code block generating step of splitting the sub-bands generated by said filtering step to generate a plurality of code blocks each being of a predetermined size;

a bitplane generating step of generating a plurality of bitplanes from the most significant bit to the least significant bit, in terms of said code block as a unit;

an encoding object predicting step of predicting the number of bitplanes for encoding, as object of the encoding, and for extracting, from an upper bit side of each code block, a number of bitplanes corresponding to the predicted number of bitplanes for encoding;

a bit modeling step of performing bit modeling from one bitplane extracted by said encoding object predicting step to another;

a step of generating an encoding pass from one bitplane to another;

an arithmetic coding step of performing arithmetic coding in the encoding passes generated by said encoding pass generating means;

a code volume controlling step of controlling the code volume, based on an arithmetic code generated by said arithmetic coding means, so that a target code volume will be reached; and

a packet generating step of appending a header to the arithmetic codes controlled as to code volume by said code volume controlling steps, to generate a packet.

15. A computer-readable recording medium having recorded thereon a program for having a computer execute preset processing, said program comprising:

a filtering step of generating a plurality of sub-bands, and applying hierarchical filtering to the sub-bands;

a code block generating step of splitting the sub-bands generated by said filtering step to generate a plurality of code blocks each being of a predetermined size;

a bitplane generating step of generating a plurality of bitplanes from the most significant bit to the least significant bit, in terms of said code block as a unit;

an encoding object predicting step of predicting the number of encoding passes for encoding, as object of the encoding, for generating the information on the number of the encoding passes;

a bit modeling step of performing bit modeling from one bitplane to another;

a step of generating an encoding pass from one bitplane to another;

an arithmetic coding step of performing arithmetic coding only on a number of the encoding passes, afforded by the information on the number of encoding passes, as counted from the most significant bit side of each code block, from among the encoding passes generated by said encoding pass generating means;

a code volume controlling step of controlling the code volume, based on an arithmetic code generated by said arithmetic coding means, so that a target code volume will be reached; and

a packet generating step of appending a header to the arithmetic code, controlled as to code volume by said code volume controlling means, to generate a packet.

16. An image encoding apparatus comprising:

filtering means for generating a plurality of sub-bands, and applying hierarchical filtering to the sub-bands;

code block generating means for splitting the sub-bands generated by said filtering means for generating a plurality of code blocks each being of a predetermined size;

bitplane generating means for generating a plurality of bitplanes from the most significant bit to the least significant bit, in terms of said code block as a unit;

bit modeling means for performing bit modeling from one bitplane to another;

encoding pass generating means for generating an encoding pass from one bitplane to another;

arithmetic coding means for performing arithmetic coding in the encoding pass generated by said encoding pass generating means;

code volume controlling means for controlling the code volume, based on an arithmetic code generated by said arithmetic coding means, so that a target code volume will be reached; and

packet generating means for appending a header to the arithmetic code, controlled as to code volume by said code volume controlling means, to generate a packet; wherein

in said code volume controlling step, said arithmetic codes are summed in a sequence from the arithmetic code with the highest bit position in the totality of the code blocks of said input picture to the arithmetic code of the lowermost bit, from one bitplane to another or from one code pass to another, and summation is halted when a preset target code is exceeded.

17. The picture encoding apparatus according to claim 16 wherein said code volume controlling means sums said arithmetic codes in the same bit position in a sequence from a sub-band of the lowermost range to a sub-band of the highest range.

18. The picture encoding apparatus according to claim 16 wherein said code volume controlling means sums said arithmetic codes in the same bit position in a

sequence from a component of the luminance information to the component of the chroma information.

19. An image encoding method comprising:

- a filtering step of generating a plurality of sub-bands, and applying hierarchical filtering to the sub-bands;

- a code block generating step of splitting the sub-band generated by said filtering step to generate a plurality of code blocks each being of a predetermined size;

- a bitplane generating step of generating a plurality of bitplanes from the most significant bit to the least significant bit, in terms of said code block as a unit;

- a bit modeling step of performing bit modeling from one bitplane to another;

- an encoding pass generating step of generating an encoding pass from one bitplane to another;

- an arithmetic coding step of executing arithmetic coding in the encoding pass generated in said encoding pass generating step;

- a code volume controlling step of controlling the code volume, based on the arithmetic code generated in said arithmetic coding step, so as to yield a target code volume; and

- a packet generating step of appending a header to the arithmetic code, the code volume of which has been controlled by the code volume controlling step, to generate a packet; wherein

in said code volume controlling step, said arithmetic codes are summed in a sequence from the arithmetic code with the highest bit position in the totality of the code blocks of said input picture to the arithmetic code of the lowermost bit, from one bitplane to another or from one code pass to another, and summation is halted when a preset target code is exceeded.

20. A program for having a computer execute preset processing, comprising:

- a filtering step of generating a plurality of sub-bands, and applying hierarchical filtering to the sub-bands;

- a code block generating step of splitting each sub-band generated by said filtering step to generate a plurality of code blocks each being of a predetermined size;

- a bitplane generating step of generating a plurality of bitplanes from the most significant bit to the least significant bit, in terms of said code block as a unit;

- a bit modeling step of performing bit modeling from one bitplane to another;

- an encoding pass generating step of generating an encoding pass from one bitplane to another;

- an arithmetic coding step of executing arithmetic coding in the encoding pass generated in said encoding pass generating step;

- a code volume controlling step of controlling the code volume, based on the arithmetic code generated in said arithmetic coding step, so as to yield a target code

volume; and

a packet generating step of appending a header to the arithmetic codes, the code volume of which has been controlled by the code volume controlling step, to generate a packet; wherein

in said code volume controlling step, said arithmetic codes are summed in a sequence from the arithmetic code with the highest bit position in the totality of the code blocks of said input picture to the arithmetic code of the lowermost bit, from one bitplane to another or from one code pass to another, and summation is halted when a preset target code is exceeded.

21. A recording medium having recorded thereon a program for having a computer execute preset processing, said program comprising:

a filtering step of generating a plurality of sub-bands, and applying hierarchical filtering to the sub-bands;

a code block generating step of splitting each sub-band generated by said filtering step to generate a plurality of code blocks each being of a predetermined size;

a bitplane generating step of generating a plurality of bitplanes from the most significant bit to the least significant bit, in terms of said code block as a unit;

a bit modeling step of performing bit modeling from one bitplane to another;

an encoding pass generating step of generating an encoding pass from one bitplane to another;

an arithmetic coding step of executing arithmetic coding in the encoding pass generated in said encoding pass generating step;

a code volume controlling step of controlling the code volume, based on the arithmetic code generated in said arithmetic coding step, so as to yield a target code volume; and

a packet generating step of appending a header to the arithmetic code, the code volume of which has been controlled by the code volume controlling step, to generate a packet; wherein

in said code volume controlling step, said arithmetic codes are summed in a sequence from the arithmetic code with the highest bit position in the totality of the code blocks of said input picture to the arithmetic code of the lowermost bit, from one bitplane to another or from one code pass to another, and summation is halted when a preset target code is exceeded.

22. An image encoding apparatus comprising:

filtering means for generating a plurality of sub-bands, and applying hierarchical filtering to the sub-bands;

quantization means for dividing transform coefficients in the sub-bands, generated by said filtering means, with a quantization step size, weighted using weighting coefficients set from one sub-band to another, by way of performing quantization;

code block generating means for splitting each sub-band following said



quantization for generating a plurality of code blocks each being of a predetermined size;

bitplane generating means for generating a plurality of bitplanes from the most significant bit to the least significant bit, from one code block to another;

bit modeling means for performing bit modeling from one bitplane to another;

encoding pass generating means for generating encoding passes from one bitplane to another;

arithmetic coding means for performing arithmetic coding in the encoding passes generated by said encoding pass generating means;

code volume controlling means for controlling the code volume, based on arithmetic codes, generated by said arithmetic coding means, so that a target code volume will be reached; and

packet generating means for appending a header to the arithmetic codes, controlled as to code volume by said code volume controlling means, to generate a packet;

said code volume controlling means summing said arithmetic codes in a sequence from the arithmetic code with the highest bit position to the arithmetic code with the lowermost bit, in the totality of the code blocks of said input picture, from one bitplane to another or from one code pass to another, said code volume controlling means halting the summation when a preset target code volume is

exceeded.

23. The image encoding apparatus according to claim 22 wherein said weighting coefficients are set so that the lower the frequency of the frequency component of a sub-band being quantized, the smaller is the quantization step size.

24. The image encoding apparatus according to claim 22 wherein said weighting coefficients are set so that the quantization step size is smaller for a component of the luminance information than for a component of the chroma information.

25. The image encoding apparatus according to claim 22 wherein said code volume controlling means sums said arithmetic codes of the same bit position in a sequence from a sub-band of the lowermost frequency to a sub-band of the highest frequency.

26. The image encoding apparatus according to claim 22 wherein said code volume controlling means sums said arithmetic codes of the same bit position in a sequence from the component of the luminance information to the component of the chroma information.

27. An image encoding method comprising:

a filtering step of generating a plurality of sub-bands, and applying hierarchical filtering to the sub-bands;

a quantization step of dividing transform coefficients in the sub-bands, generated by said filtering step, with a quantization step size, weighted using

weighting coefficients set from one sub-band to another, by way of performing quantization;

a code block generating step of splitting each sub-band following said quantization for generating a plurality of code blocks each being of a predetermined size;

a bitplane generating step of generating a plurality of bitplanes from the most significant bit to the least significant bit, from one code block to another;

a bit modeling step of performing bit modeling from one bitplane to another;

an encoding pass generating step of generating encoding passes from one bitplane to another;

an arithmetic coding step of performing arithmetic coding in the encoding passes generated by said encoding pass generating step;

a code volume controlling step of controlling the code volume, based on an arithmetic code generated by said arithmetic coding step, so that a target code volume will be reached; and

a packet generating step of appending a header to the arithmetic code, controlled as to code volume by said code volume controlling step, to generate a packet;

said code volume controlling step summing said arithmetic codes in a sequence from the arithmetic code with the highest bit position to the arithmetic code with the lowermost bit, in the totality of the code blocks of said input picture,

from one bitplane to another or from one code pass to another, said code volume controlling step halting the summation when a preset target code volume is exceeded.

28. A program for having a computer execute a preset processing, said program comprising:

- a filtering step of generating a plurality of sub-bands, and applying hierarchical filtering to the sub-bands;

- a quantization step of dividing transform coefficients in the sub-bands, generated by said filtering step, with a quantization step size, weighted using weighting coefficients set from one sub-band to another, by way of performing quantization;

- a code block generating step of splitting each sub-band following said quantization for generating a plurality of code blocks each being of a predetermined size;

- a bitplane generating step of generating a plurality of bitplanes from the most significant bit to the least significant bit, from one code block to another;

- a bit modeling step of performing bit modeling from one bitplane to another;

- an encoding pass generating step of generating encoding passes from one bitplane to another;

- an arithmetic coding step of performing arithmetic coding in the encoding passes generated by said encoding pass generating step;

a code volume controlling step of controlling the code volume, based on the arithmetic codes, generated by said arithmetic coding step, so that a target code volume will be reached; and

a packet generating step of appending a header to the arithmetic codes, controlled as to code volume by said code volume controlling step, to generate a packet;

said code volume controlling step summing said arithmetic codes in a sequence from the arithmetic code with the highest bit position to the arithmetic code with the lowermost bit, in the totality of the code blocks of said input picture, from one bitplane to another or from one code pass to another, said code volume controlling step halting the summation when a preset target code volume is exceeded.

29. A computer-readable recording medium, having recorded thereon a program for having a computer execute a preset processing, said program comprising:

a filtering step of generating a plurality of sub-bands, and applying hierarchical filtering to the sub-bands;

a quantization step of dividing transform coefficients in the sub-bands, generated by said filtering step, with a quantization step size, weighted using weighting coefficients set from one sub-band to another, by way of performing quantization;

a code block generating step of splitting each sub-band following said

quantization for generating a plurality of code blocks each being of a predetermined size;

a bitplane generating step of generating a plurality of bitplanes from the most significant bit to the least significant bit, from one code block to another;

a bit modeling step of performing bit modeling from one bitplane to another;

an encoding pass generating step of generating encoding passes from one bitplane to another;

an arithmetic coding step of performing arithmetic coding in the encoding passes generated by said encoding pass generating step;

a code volume controlling step of controlling the code volume, based on the arithmetic codes, generated by said arithmetic coding step, so that a target code volume will be reached; and

a packet generating step of appending a header to the arithmetic codes, controlled as to code volume by said code volume controlling step, to generate a packet;

said code volume controlling step summing said arithmetic codes in a sequence from the arithmetic code with the highest bit position to the arithmetic code with the lowermost bit, in the totality of the code blocks of said input picture, from one bitplane to another or from one code pass to another, said code volume controlling step halting the summation when a preset target code volume is exceeded.